HIGH PRODUCTION NUTCRACKING APPARATUS WITH SEALED LUBRICATION SYSTEM

BACKGROUND OF THE INVENTION

The present invention relates to an improved high production nutcracking apparatus, of the type disclosed for example in U.S. Patent Nos. 4,332,827; 5,623,867; 6,205,915; and 6,584,890.

The nutcracking apparatus as disclosed in the above patents includes a rotatable turret which mounts a plurality of cracking units arranged about its periphery, with each cracking unit having an opening adapted to receive an individual nut from a nut feed conveyor which comprises a plurality of nut transport elements mounted in succession on a feed chain. Each of the nut transport elements includes an upwardly open transverse receptacle for holding an individual nut, and each cracking unit on the turret has an anvil which is moved axially into the receptacle at a pickup point so that the nut is engaged between the anvil and a crack die on the other side of the opening.

In operation, the feed conveyor moves tangentally past the rotating turret so that the anvils of the cracking units enter the receptacles of respective nut transport elements at the pickup point and engage and pick up the nut. After the cracking unit and engaged nut have moved away from the pickup point, the crack die of the cracking unit in impacted by a shuttle so that the crack die applies an impact to the nut to crack the shell.

The control system for cyclically actuating the cracking units includes an air control system whereby air is selectively introduced into four ports of each

cracking unit. Also, as indicated in U.S. Patent No. 4,332,827, it is conventional to place an air oiler and a filter in the air supply manifold line, to lubricate the moving components of the cracking units. While such lubrication minimizes wear, it can cause environmental concerns resulting from the escape of oil, either as a liquid which drips to the floor or as an oil mist which enters the surrounding atmosphere.

It is an object of the present invention to provide a lubrication system for a high speed nutcracking apparatus of the described type, and which is substantially sealed so as to minimize the escape of the oil, either as a liquid or in the form of an oil mist.

SUMMARY OF THE INVENTION

The above and other objects and advantages of the invention are achieved by the provision of an essentially closed lubrication system which incorporates an oil recovery system for recovering oil from the air/oil mixture after it has been delivered to and exhausted from the cracking units. The recovery system includes a cowling sleeve attached to the valve plate of the turret so as to surround the radial periphery of the end plate and the filtering pad of the turret. The cowling sleeve has an annular free end remote from the valve plate and defines an annular collection chamber surrounding the periphery of the filtering pad and the end plate. Also, a drain communicates with the lower portion of the collection chamber, and an annular barrier member is provided for restricting the flow of oil which is received in the collection chamber in a direction toward said free end of the cowling sleeve and so that the oil is guided into the drain.

An oil tank is provided for receiving any oil exiting from the drain of the collection chamber and from an exhaust line which is connected to an opening of the valve plate which vents the air from the cracking units. Also, an oil recirculation system is provided for delivering oil from the tank to the air delivery system to form the oil mist component of the pressurized air delivered to the cracking units.

The oil tank has a first upper chamber communicating with the drain and with the exhaust line, a second upper chamber communicating with an outlet line, a lower oil delivery line communicating with the oil recirculation system, and a perforated baffle plate positioned to extend downwardly into oil in the tank and separating the first and second upper chambers from each other.

The turret further includes an axial support shaft extending along its rotational axis, with the shaft extending through aligned openings in each of the end plate, the felt pad, and the valve plate. A resilient sealing gasket is disposed between the shaft and each of the end plate and the valve plate.

BRIEF DESCRIPTION OF THE DRAWINGS

Some of the objects and advantages of the invention having been stated, others will appear as the description proceeds, when taken in connection with the accompanying drawings, in which:

Fig. 1 is a partly sectioned side elevation view of a nutcracking apparatus of the described type and which embodies the prior art lubrication system;

Fig. 2 is a view similar to Fig. 1 but illustrating the oil lubrication and recovery systems of the present invention;

Fig. 2A is an enlargement of the portion shown within the circle 2A of Fig. 2;

Fig. 3 is an expanded perspective view of the end plate, filtering pad, and valve plate of the turret of the present invention;

Figs. 4-6 are sectional views of three embodiments of the recovery system of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring more specifically to the drawings, Fig. 1 illustrates in more detail a nut cracking apparatus of the prior art as generally described above. As illustrated, the prior apparatus is indicated by the numeral 10, and it includes a rectangular box-like frame 12 which supports a pair of bearing blocks **14** (only one being shown) which rotatably mount a central shaft **20** which defines a horizontal central axis.

A turret **22** is fixedly mounted to the shaft **20** so as to be rotatable with the shaft about the central axis. The turret **22** comprises a plurality of elongate cracking units **24** which are circularly arranged about the shaft and supported by the end plates **25** and **26**, and the intermediate plates **27**, **28** and **29**. There are sixteen cracking units in the illustrated embodiment and the units extend generally parallel to each other and to the central axis.

Each of the cracking units **24** comprises an anvil **32**, and a cracking die assembly **34** which includes a cracking die **35**. The anvil and cracking die assembly are mounted in an axially aligned, opposed relationship to define an opening for receiving a nut **N** therebetween. More particularly, the means for mounting the anvil **32** includes a first air cylinder **37**, a piston **38** slidably disposed within the cylinder **37**, a piston rod **39**

interconnecting the piston and anvil, a first air port **40** disposed adjacent the rearward end of the cylinder, and a second air port **42** disposed adjacent the forward end of the cylinder. As will be apparent, movement of the piston **38** results in a corresponding movement of the anvil **32**, either forwardly toward the cracking die assembly **34** or rearwardly therefrom. Such movement is controlled by air which is selectively provided to the first and second ports **40**, **42** in a manner more fully disclosed in U.S. Pat. Nos. 4,418,617; 4,441,414; and 6,182,562.

The cracking die assembly **34** is more fully described in the above referenced patents, the disclosures of which are all expressly incorporated herein by reference, and it includes the cracking die **35**, and a second air cylinder **44**. A free floating shuttle **46** is mounted so as to be closely received within the bore of the cylinder **44**. In addition, there is provided an air port **47** adjacent the forward end of the cylinder and a further port **48** which extends axially through the rearward end of the cylinder.

The turret 22 further includes a cylindrical cover plate **50** which encloses the anvils **32** and first air cylinders **37**, and a second cylindrical cover plate **52** which encloses cracking die assemblies **34** and second air cylinders **44**.

The control system for cyclically actuating the cracking unit includes an air control system whereby air, which includes a lubricating oil mist, is selectively introduced into the four ports **40** **42**, **47**, and **48**. More particularly, upon receiving a nut **N** in the opening between the anvil **32** and cracking die assembly **34**, air is first introduced into the port **40** so that the piston **38** and anvil **32** are moved forwardly and such that the anvil

32 operatively engages one end of the nut **N** in the opening. The nut thereby becomes supported between the anvil **32** and cracking die **35**. The anvil **32** and cracking die **35** thereby also serve to compressively stress the retained nut. High pressure air is next injected through the port **48** and into the air cylinder **44**, such that the shuttle **46** is thrust forwardly along the cylinder and impacts against the rear end surface of the cracking die **35**, causing the cracking die to sharply advance a short distance forwardly against the nut and thereby crack its shell. The air in front of the advancing shuttle is permitted to exhaust through the port **47**. Air next enters the port **42**, causing the piston **38** and anvil **32** to move rearwardly and release the nut, and as a final step, air is caused to enter the port **47** and thereby return the shuttle **46** to its rearward position. The apparatus is then in position to receive another nut to be cracked, with the above cycle being cyclically repeated. Further details regarding the air control system for cyclically actuating the apparatus **10** may be obtained from the above noted prior patents.

The prior apparatus as shown in Fig. 1 further includes an apparatus for advancing and delivering a plurality of nuts individually in succession along a path of travel to the rotating turret **22**. The nut delivering apparatus is not illustrated herein, but a complete disclosure thereof may be obtained from the above referenced patents, the disclosures of which are expressly incorporated herein by reference.

The ports **40**, **42**, **47** and **48** of the cracking units are each connected via an air line to one side of the end plate **26** and so as to communicate with respective openings which extend through the end plate, note Fig. 3.

A valve plate **54** is fixedly mounted to the machine frame so as to be positioned parallel to and spaced from the other side of the end plate **26**, and the valve plate **54** includes a plurality of inlet openings **55** which are positioned for sequential alignment with selected ones of the openings in the end plate as the turret is rotated. The inlet openings each communicate with an air delivery line **56** on the side thereof opposite the end plate **26**. The valve plate **54** further includes single outlet opening **57** positioned for sequential alignment with each of the openings in the end plate **26** which are connected to the exhaust ports **47** of the air cylinders **44** as the turret is rotated. The outlet opening **57** in the valve plate is connected to an exhaust line **58** on the side thereof opposite the end plate.

The valve plate **54** includes two service or inspection openings **59**, **59'**, respectively, which form no part of the present invention.

An air delivery system is provided for delivering pressurized air which includes an oil mist component to each of the air delivery lines **56** such that the pressurized air/oil mist is selectively delivered to and exhausted from said cracking units during rotation of the turret. The air delivery system includes a pressurized air source **60** which delivers the air to a manifold and then to the individual air delivery lines **56** via a pressure regulator **61** and a metering valve **62** which slowly drips oil from an oil delivery line **63** into the air delivery line **56**. The oil is thereby vaporized to form the air/oil mist which is delivered to the cracking units.

A filtering pad **64** is fixedly mounted in the space between the end plate **26** and the valve plate **54**, with the filtering pad **64** having a plurality of inlet openings **55'**

aligned with respective ones of the inlet openings **55** in the valve plate **54**, and an outlet opening **57'** which is aligned with the outlet opening **57** in the valve plate **54**. Thus when the high pressure air is injected into the air cylinder **44** to thrust the shuttle **46** forwardly, the air in front of the shuttle is free to move freely through the port **47** and the outlet opening **57** to the exhaust line **58**. The pad **64** includes two service and inspection openings **59'** which are aligned with the openings **59** in the valve plate **54**. This condition is illustrated in Fig. 1.

As illustrated in connection with the lowermost cracking unit **24** shown in Fig. 1, the filtering pad **64** forms a filtering barrier which is aligned with the remainder of the openings in the end plate **26** when such openings receive exhausted air from the associated cracking unit. Thus the pad **64** tends to entrap and collect the oil which is entrained with the air as it exhausts through these openings.

The prior apparatus as illustrated in Fig. 1 includes an oil recovery system which includes a cowling sleeve **66** attached to the valve plate **54** so as to surround the radial periphery of the end plate **26** and the filtering pad **64**. A drain extends through the lower portion of the valve plate **54** and communicates with a drain line **68** which is connected on the outer side of the valve plate **54**. Thus the oil which is entrapped in the filtering pad **64** during operation of the machine tends to flow downwardly onto the cowling sleeve **66** and into the drain and the drain line **68**.

The oil recovery system further includes an oil tank **70** into which the exhaust lines **58** and the drain line **68** empty. A vent **71** is provided in the upper chamber of the

tank, and a lower output line **72** supplies oil to the line **63** and metering valve **62** via a pump **73** and filter.

As indicated above in the background section of the specification, the oil lubrication system of the prior apparatus is the subject of environmental concerns resulting from the escape of oil. In particular, oil tends to collect and drip from the cowling sleeve **66**, and oil which collects in the pad **64** tends to leak through the bearings of the shaft **20**. Further, the air which passes outwardly from the tank via the vent **71** tends to entrain oil and form a mist which is vented to the atmosphere.

The above environmental concerns are effectively avoided with the apparatus of the present invention, which is illustrated in Figs. 2-6. More particularly, and in accordance with the present invention, there is provided an improved oil recovery system which is essentially sealed against the loss of oil into the surrounding environment. In the embodiment shown in Figs. 2 and 2A, the cowling sleeve **66** is mounted so as to be radially spaced a rather significant distance (typically about 1 inch) from the outer periphery of the end plate **26**. Also, an annular barrier member, which is in the form of a resilient gasket **75**, is mounted so as to be fixed on the inside of the cowling sleeve **66** and it is sized to bear against the outer periphery of the cover plate **52** or the end plate **26**. Thus a closed collection chamber **76** is formed which surrounds the periphery of the filtering pad **64** and communicates with the drain. The oil which collects in the pad and drains downwardly onto the cowling sleeve **66** is thereby retained in the closed collection chamber **76** and passes out through the drain line **68**.

The resilient gasket **75** comprises a closed annular ring of a suitable elastomeric material and in cross section it will be seen to have a base portion which may be reinforced with cords and a flexible upper leg which optionally can be biased toward the cover plate or end plate by an annular spring **78**.

The annular gasket **75** acts to generally seal the collection chamber **76** to the passage of air and so that the chamber becomes somewhat pressurized by the air which enters and exhausts from the cracking units and then passes through the filtering pad **64** to the collection chamber. The pressurization of the chamber serves to force the oil which collects therein into and through the drain line **68**.

As seen in Fig. 2, the drain line **68** communicates with a first upper chamber **81** of an oil tank **80**, and the several exhaust lines **58** also communicate with the first upper chamber **81**. The tank **80** includes an air porous baffle plate **82** which extends from the cover of the tank downwardly into the oil which is held in the tank. Also, the baffle plate **82** forms a second upper chamber **83** which communicates with an outlet **84** which leads to a vacuum air exhaust system **85** which is provided on the machine for removing air and entrained debris from the vicinity of the turret. A lower outlet **72** is also provided, which leads to the air supply manifold via a pump and filter **73**. Thus the oil collected in the tank may be recirculated from the tank to the air delivery system to form the oil mist component of the pressurized air delivered to the cracking units.

The baffle plate **82** preferably comprises a metal plate which is perforated by a plurality of very small openings which are designed to condense and hold the oil in the first chamber **81** while allowing the passage of the

cleaned air to the outlet **84**. A metal plate having myriad openings of a diameter of about .010 (ten thousandths) of an inch is suitable for the purpose. The plate **82** could also take the form of a porous fabric or a sheet of filtering medium.

Also in accordance with the present invention, the axial support shaft **20** is sealed to each of the end plate **26** and the valve plate **54**. As best seen in Fig. 3, the seals **87, 88** may take the form of resilient O-rings which are held in cutouts in the end plate and the valve plate respectively. The seals thus prevent any oil from leaking from the filtering pad **64** outwardly along the shaft **20** in either direction.

Fig. 4 illustrates an embodiment of the oil recovery system which further includes an annular brush **90** positioned to extend between the outer free end of the cowling sleeve **66** and the cover plate **52** of the turret. The brush **90** serves to prevent the entry of debris, such as shell fragments, from entering between the gasket **75** and the end plate, and it is supported by a metal retainer **91** which is crimped to retain the brush and secured to the cowling sleeve **66**.

Fig. 5 illustrates an embodiment wherein the annular barrier member comprises an annular elastomeric band **92** which is sized to overlie and be supported on the outer periphery of the cover plate **52** so as to be aligned with the end plate **26**. The band **92** acts as a slinger during rotation of the turret to throw any oil running along the inside of the end plate onto the cowling sleeve **66**, as indicated by the arrow. Also, the free end of the cowling sleeve incorporates an annular end dam **93** which prevents the oil in the collection chamber **76** from flowing out and thereby assures that the oil enters the drain.

Fig. 6 illustrates an embodiment wherein the outer periphery of the end plate **26'** incorporates integral grooves **95** which act as slingers in the manner described above, and a sealing member in the form of a vinyl coated sponge rubber ring **96** is mounted so as to encircle the cover plate **52** adjacent the end plate **26'**. The ring has a generally circular cross section, and a vinyl clip **97** is mounted at the free end of the cowling sleeve **66** to engage the ring, which rotates with the turret **22**, and thereby minimize friction. The ring **96** thereby essentially closes the collection chamber **76**, so that the oil which is thrown onto the cowling sleeve is retained thereon until it passes into the drain. In this embodiment, the drain passes radially through the cowling sleeve **66**.

In the drawings and specification, there have been set forth preferred embodiments of the invention, and although specific terms are employed, they are used in a generic and descriptive sense only, and not for purposes of limitation.